Course Title: Signals and Systems	Course Code: CCE2210	Year: 2nd
Date: June 26th 2011 (Second term)	Allowed time: 3 hrs	No. of Pages: (2)

Remarks: (Answer the following questions)

Problem number (1) **(10 Marks)**

a) Define the following terms **[6 Marks]**

- Controllability - Observability - Open-loop and closed-loop systems
- Stability - Causality - Transfer function

b) Let $h(t)$ be the unit impulse response of an LTI system, where **[4 Marks]**

$$h(t) = u(t-2) - u(t-4)$$

Find the output response using the convolution integral for the following input

$$x(t) = u(t) - 2u(t-1) + u(t-2)$$

Problem number (2) **(20 Marks)**

a) Figure 1 shows a schematic diagram of an armature–controlled DC servomotor **[10 Marks]**

(i) Find the differential equations,

(ii) Draw the block diagram, then

(iii) Find the transfer function

$(\theta(s)/V_a(s))$

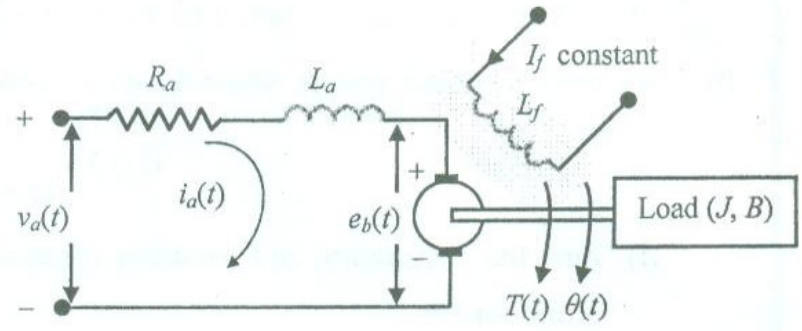

Figure 1

b) A simple lumped model of the national income الدخل القومى feedback control system is shown in Figure 2. This type of model helps the analyst to understand the effects of government control and the dynamic effects of government spending الإنفاق الحكومي. **[10 Marks]**

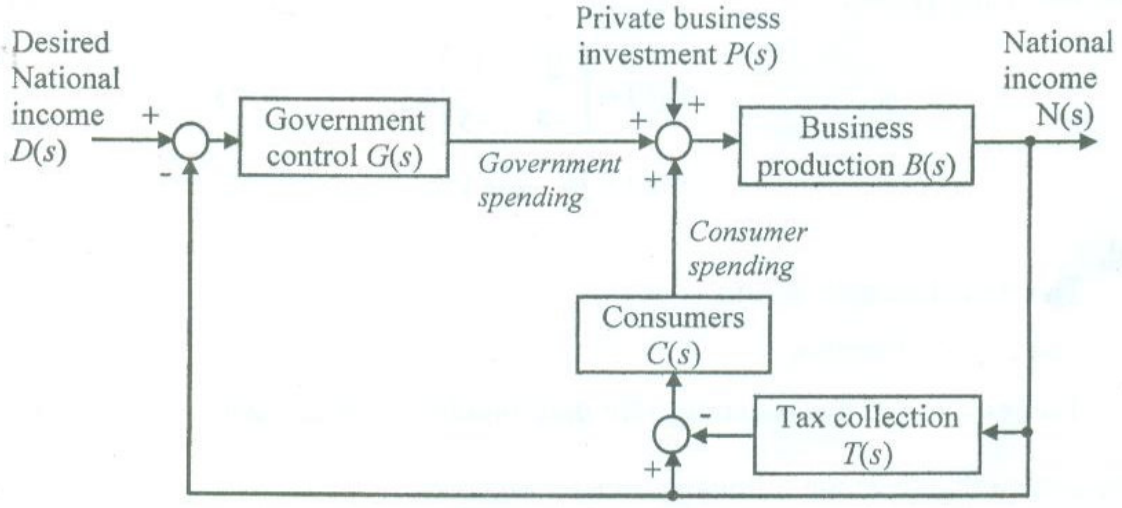

Figure 2

Find the output (National income $N(s)$) as a function of the inputs (desired national income $D(s)$ and private business investment الاستثمار $P(s)$).

P.T.O.

Problem number (3) **(15 Marks)**

a) Consider the following characteristic polynomial **[6 Marks]**

$$Q(s) = s^4 + s^3 - s - 1$$

Apply Routh stability criterion to find the distribution of the poles in the s-plane and to check the stability of the system.

b) The overall transfer function of a closed loop system is given by **[9 Marks]**

$$T(s) = \frac{50}{s(1+ks)(1+0.5s)+50}$$

Find the value of k for the system to be critically stable, and then find the frequency of oscillation.

Problem number (4) **(20 Marks)**

a) Find the peak time, maximum overshoot, and rise time of the following systems **[10 Marks]**

(i) A system with transfer function $T(s) = \frac{100}{s^2 + 15s + 100}$

(ii) A second order system with poles at $-2 + j2$ and $-2 - j2$

b) For a unity feedback system which have the open-loop transfer function **[10 Marks]**

$$G(s) = \frac{10k}{(s+1)(s+2)(2s+1)}$$

(i) Find the step, ramp, and parabolic error coefficients and the corresponding steady-state errors for $k = 1$.

(ii) It is desired that, for unit step input, the steady state error $e_{ss} \leq 0.1$, find the range of k, which is investigating this requirement while maintaining the stability of the system.

Problem number (5) **(25 Marks)**

a) For the following system **[15 Marks]**

$$\dot{x}(t) = \begin{bmatrix} 0 & 1 \\ -4 & -5 \end{bmatrix} x(t) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t)$$

$$y(t) = \begin{bmatrix} 1 & 1 \end{bmatrix} x(t)$$

Find,

(i) The state transition matrix.

(ii) The transfer function.

(iii) The response of the system $y(t)$ for unit impulse input and zero initial condition.

b) For the system that have the following transfer function **[10 Marks]**

$$\frac{Y(s)}{U(s)} = \frac{s^2 + 15s + 50}{(s+1)(s^2 + 6s + 8)}$$

(i) Obtain the state space model.

(ii) Determine whether the system in (i) is controllable and observable or not.

GOOD LUCK

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